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## Port System of the Spanish South Peninsular Coast Side

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### ABSTRACT

This study aims at doing a comparative analysis of the Spanish South Peninsular Port Authorities, in the period 2008-2012, and their positioning based on their perception about the 'innovative effort they have made' in the period 2004-2009. In order to achieve this aim, first, a comparative analysis of freight traffic has been carried out in order to obtain an overview of the Spanish South Peninsular watershed; secondly, the strengths and weaknesses of each Port Authority have been identified based on the variable 'perceived innovative effort'.

As a result of the analysis, the specialization of each Port Authority is shown. Thus, Algeciras is the Port Authority with the highest container traffic due to its specialized infrastructures.

In addition, a detailed analysis of the specific facilities of each Port Authority has allowed us to get more information about the specialization of Port Authorities.

Finally, the strengths and weaknesses analysis provides an overview of the situation of each Port Authority, indicating the potential lines of action and improvement that they can follow.

We consider that this study may be useful for the Port Authority managers and policy makers due to it offers an overview of the situation of the Port Authority compared to its nearest competitors, helping with decision making and resource allocation.

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## 1. Introduction

The Spanish port system consists of 46 ports of general interest, managed by 28 Port Authorities (PA) (see figure 1), which are also dependent on the Public Authority *Puertos del Estado*, which in turn depends on the Ministry of Foment.

Since the 1990s, the ports have developed their activity in a highly competitive environment, especially between nearby

ports. Given this situation, and considering that the Spanish port system could be oversized, it is interesting to know the position of the PAs by analyzing their strengths and weaknesses. Especially interesting is the competition between ports of the same watershed.

On the other hand, in the search for competitiveness, innovation is said to be a source of sustainable competitive advantages and differentiation.

It is in this context that the objective of the present work is set, which is to carry out a comparative analysis of the PAs, in particular those of the Spanish South Peninsular Watershed, and their positioning based on their perception of the "innovative effort made". A similar study for the Spanish Mediterranean watershed ports can be seen in (Blanco et al., 2015).

First, a comparison of all the ports is made so that an overall view of the situation of the watershed can be obtained. This comparison will be made by analyzing freight traffic and infrastructure data. In the second part, we include an analysis of the strengths and weaknesses of each port, in relation to the total score of the watershed, based on the variable "perception of

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innovative effort carried out by the PAs". In order to do this, Rasch Measurement Theory has been applied to the information obtained through a survey.

The PAs of the Spanish South Peninsular Coast are (See Figure 1): Almería, Bahía de Algeciras, Bahía de Cádiz, Huelva, Málaga, Motril and Sevilla.



Source: Ministerio de Fomento. Puertos del Estado

The first part of the comparative analysis of the ports of the watershed is made taking into account the evolution of the traffic of goods from 2008 to 2012; either in the form of liquid bulk, solid bulk or general merchandise, as well as distinguishing what goods are transported in containers or using Ro-Ro systems. The objective was to make a comparison of the ports to deduce the specialization of each of them and their market shares.

In the second part, the number and characteristics of the infrastructures, facilities and cranes that each port has, are compared. Through the observation of their infrastructures, the specialization of the ports and the possible causes of the greater or lesser traffic of goods could be evidenced.

In the third part, the weaknesses and strengths of each port are analyzed through the Rasch Measurement Theory.

Finally, a chapter of conclusions, the bibliography and the appendixes are included.

## 2. Compared Analysis of the Port Authorities

The objective of the comparative analysis of the ports is to establish the specialization of each one of them and their market shares. This section compiles the comparison for the different traffic types and infrastructures.

The elaboration of this section has been made from information obtained in the web pages of "Puertos del Estado" and Port Authorities.

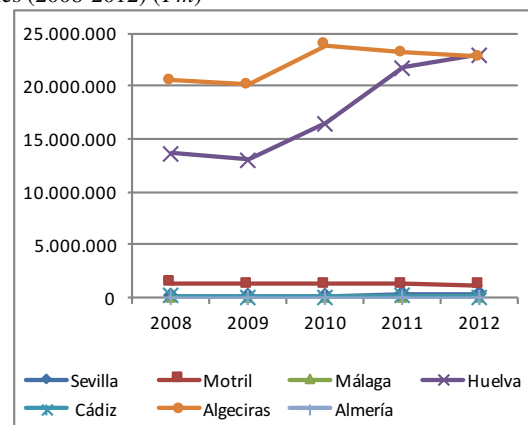
### 2.1. Comparison of Traffic

Figures 2, 3 and 4 show the evolution of traffics (liquid bulk, solid bulk and general goods) during the period 2008-2012, comparing the ports of Spanish South Peninsular watershed. Quantities are expressed in Tm. In addition, figures 5 and 6 present the distribution of container traffic and ro-ro transport in 2012, the last year analyzed for each port.

#### 2.1.1. Comparison of Traffic

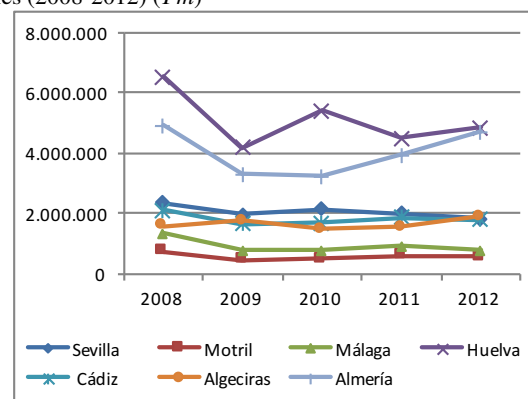
Figure 2 shows that the main ports of the Spanish South Peninsular watershed, regarding liquid bulk traffic, are Algeciras and Huelva.

Figure 2: Liquid bulk traffic of the Spanish South Peninsular Port Authorities (2008-2012) (Tm)



Source: The authors

Figure 3: Liquid bulk traffic of the Spanish South Peninsular Port Authorities (2008-2012) (Tm)



Source: The authors

#### 2.1.2. Solid Bulk Traffic

Figure 3 shows that the most important port in terms of solid bulk traffic is Huelva, followed by Almería in a second position and the ports of Sevilla, Cádiz, Algeciras, Málaga and Motril.

#### 2.1.3. General Goods Traffic

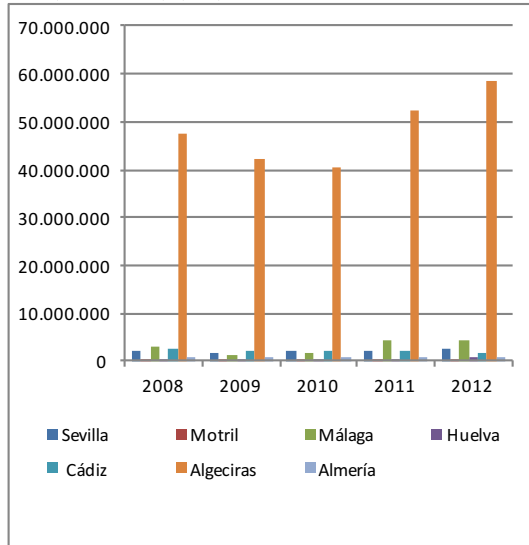
As it can be seen in figure 4, Algeciras is the most important port by far, achieving in 2012 a total of 58.611.305 Tm.

#### 2.1.4. Containers traffic

Figure 5 shows the distribution of container traffic by Spanish South Peninsular PAs. Algeciras moved a total of 4.114.231 containers covering 87% of the containers moved during the whole year (4.716.112 containers). The second port, by order of importance, is Málaga, represented by 7%. Finally, the other

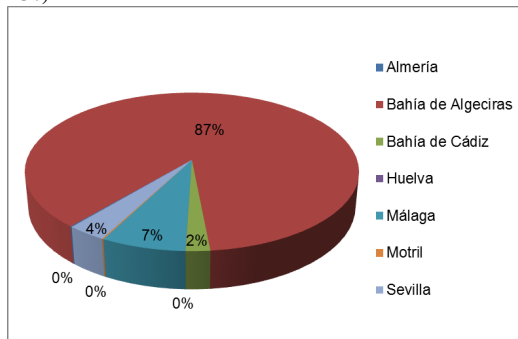
PAs sum up the remaining 6%. Therefore, it might be concluded that the other ports are not specialized in this kind of traffic.

Figure 4: General goods traffic of the Spanish South Peninsular Port Authorities (2008-2012) (Tm)



Source: The authors

Figure 5: Percentage of containers traffic of each Port Authority in 2012 (% of TEUs)



Source: The authors

### 2.1.5. Ro-Ro Traffic (Roll-on, Roll-off)

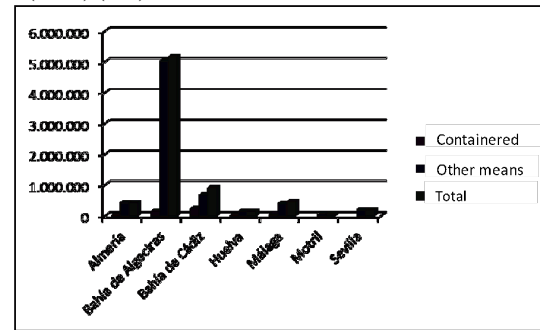
Figure 6 shows the ro-ro traffic of the Spanish South Peninsular PAs in 2012. The port of Bahía de Algeciras is the most important in ro-ro traffic. In all ports the goods transported in the ro-ro traffic are mostly non-containerized and transported through other means.

The ro-ro traffic specific of cars (as a good), and their distribution among the PAs of the watershed in 2012, is shown in figure 7. Bahía de Algeciras is the port which transports more cars as goods, with 84% of the total units (348.861 units). The other analyzed ports represent, all together, the remaining 16%, this is, 56.057 transported units.

## 2.2. Comparison of Infrastructures

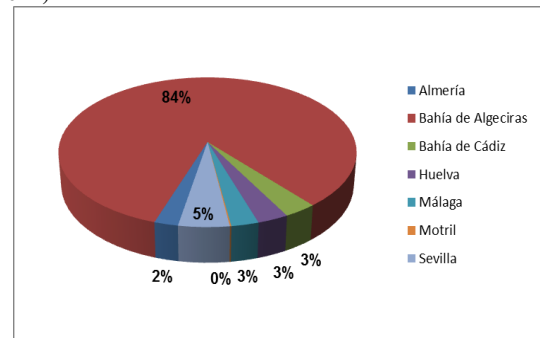
This section compiles the comparative analyses of the special facilities and cranes of the Spanish South PAs.

Figure 6: Goods moved in Ro-Ro traffic of the Spanish South Port Authorities (2012) (Tm)



Source: The authors

Figure 7: Vehicles under the Ro-Ro good system in the Spanish South PAs (2012)



Source: The authors

### 2.2.1. Special Facilities

Table 1 summaries the special facilities that each of the PA has, where x indicates that the special installation is available.

The ports with a higher number of facilities are Almería and Huelva, both of them have eight facilities, two of them in common: the ice factories and the refrigerated stores.

Cádiz has seven specialized facilities such as: refrigerated store, loading and unloading of cement, loading and unloading of cereals, loading and unloading of clinker, store for Airbus 380 components, ice factory and loading and unloading of bituminous products.

Then, the port of Algeciras is found whose specialized facilities are: refrigerated store, coal, cement, clinker, containers (as it was aforementioned Algeciras is the port with the highest level of container traffic among the analyzed ports) and ice factories.

Regarding Motril and Sevilla, it should be highlighted that they only have four specialized facilities, three of them in common: loading and unloading of cement, loading and unloading of clinker and ice factories.

### 2.2.2. Cranes

The comparison of cranes is summarized in table 2. Algeciras is the port with the largest cranes. Among them, the big spring cranes should be noticed.

Table 1: Comparison of the special facilities of each Port Authority (2012)

Special Facilities	Almeria	Algeciras	Cádiz	Huelva	Málaga	Motril	Sevilla
Airbus 380 Components			X				
Ashes	X						
Asphalt Stote						X	
Bituminuous Products			X				
Caustic Soda				X			
Cement	X	X	X		X	X	X
Cereals			X				
Clinker	X	X	X		X	X	X
Coal		X					
Containers		X					
Fertilizers Loading							
Conveyor				X			
Ice Factories	X	X	X	X	X	X	X
Loading Ramps for Ferries					X		
Petroleum Coke	X						
Phosphate				X			
Pipes for Ammonia				X			
Plaster	X						
Raw Oil					X		
Refrigerated Store	X	X	X	X	X		X
Slag	X						
Sulfuric Acid				X			

Table 2: Comparison of cranes in the Spanish South Peninsular APs (2012)

	Almeria	Algeciras	Cádiz	Huelva	Málaga	Motril	Sevilla
Spring Cranes							
Between 1 and 10	X		X	X	X		
Between 10 and 20							X
>20		X					
Automobiles Cranes							
Between 1 and 10			X			X	X
>10		X		X			

### 3. Strengths and Weaknesses Analysis

In this section a strengths and weaknesses analysis of each South Peninsular PA is developed. It is based on their perception of their own "perceived innovative effort" in different management areas.

#### 3.1. Methodology

The present study is based on a survey carried out among the 28 Spanish PAs in a previous study (Serrano et al., 2009). In that survey, among other issues, the Spanish Public Administrations were asked what they perceived to be the innovative effort they made in various activities or areas of innovation (see Appendix 1). The reliability and validity analysis can be found in (Blanco et al., 2010).

Rasch Measurement Theory was used for the analysis. The computer software used to treat the data was Winsteps 3.75 (Linacre, 2011). Specifically, two of its applications were used:

##### a) Variable Map

A first positioning, both of ports and of items, is obtained in the variable map. On the left side the subjects (the Port

Authorities in this case) are located: those located above have a better positioning than those located below. On the right side the items are located (innovation activities in this case) ordered from most important (at the bottom) to least important (at the top). See Figure 9.

##### b) Diagnostic Maps: PKMAP

For the strengths and weaknesses analysis, one of the applications of the Rasch methodology has been used, namely the PKMAP (diagnostic maps). In this respect the works of (Sanchez et al., 2012) and (Sanchez et al., 2013) incorporate a brief explanation of these tools. It should be noted that, unlike the two studies mentioned above, in the present work a more detailed study of the watershed is made since it is understood that the competition is much greater between the nearest ports.

Through the PKMAP, the program makes a comparison between the individual evaluations of each item and the global evaluation of each item for the whole set of subjects. The result is displayed on a diagnostic map (PKMAP).

In the case of this study the assessments that a Port Authority gave to each of the 16 items, that make up the construct

“perception of the innovative effort made by the AAPPs of the Spanish South Peninsular slope”, are compared with the average importance given jointly to each of the items. Thus, for example, if a Port Authority has a 5 (maximum value) in an item that is not valued by the PAs as a whole, it would have a strength since the innovative effort that the Authority made in this aspect is much greater than the one made in general terms by the set of Port Authorities. On the contrary, if a Port Authority has a score of 1 (minimum value) in a highly valued item, it has a weakness, since its innovative effort is very small in an item in which, in general, the innovative effort made is great.

The diagnostic map is divided into four quadrants in which the different items will be distributed according to the response given by the subject to each of them (Figure 8). The middle zone in grey represents the level of the subject.

In the upper left quadrant, quadrant 1, those items in which the subject has a strength are located. These would be activities in which the Port Authority makes a bigger innovative effort than the average. In the lower right quadrant, quadrant 4, the weaknesses of the Port Authority are located. They are the activities in which it does not make enough innovative effort, while the other Port Authorities do.

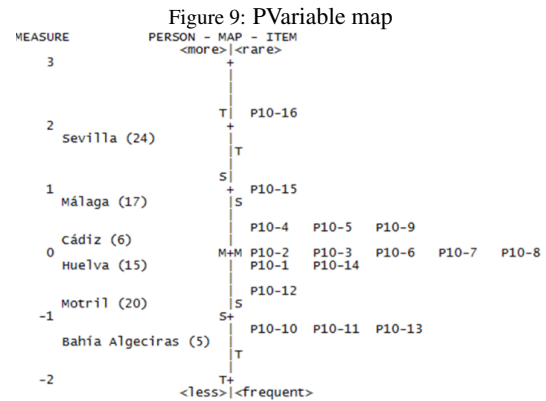
The other two quadrants have less interest. Quadrant 3, which is the lower left quadrant, indicates the activities in which Port Authorities have made some effort, but that it does not suppose any advantage, since the others also have made it. The upper right quadrant, quadrant 2, includes the activities in which no effort has been made, but neither the other.

Figure 8: PKMAP Quadrants Interpretation

	ANSWERED CORRECTLY	ANSWERED INCORRECTLY
DIFFICULT ITEMS	QUADRANT 1 (STRENGTHS)	QUADRANT 2 (EXPECTED)
EASY ITEMS	QUADRANT 3 (EXPECTED)	QUADRANT 4 (WEAKNESSES)

Source: The authors

to the greater or lesser innovative effort that the Spanish South Peninsular PAs perceive to have developed. The results are presented in Figure 9 and in Table 3. Almería is not included in the analysis due to it did not answer to the survey.



Source: The authors

Table 3: Items ranking

Item Position	Item Number	Item Description
1	P10-13	Contingency plans and security systems for protecting infrastructure and the environment
2	P10-11	Information Systems, Communication and Control systems
3	P10-10	Environmental Issues
4	P10-12	Plans and Protection Systems
5	P10-14	Projects and Construction
6	P10-1	Strategic Planning
7	P10-8	External Relations
8	P10-7	Legal Services and Administrative Management
9	P10-6	Finance and Economics
10	P10-3	Port Services
11	P10-2	Human Resources
12	P10-9	Quality
13	P10-5	Sales and Marketing
14	P10-4	Management of Soncessions and Autorizations
15	P10-16	Promotion and Sponsorship of Scientific and Technological R&D within the port
16	P10-15	Maintenance

Based on this ranking, the next step is to identify the strengths and weaknesses of each PAs using the PKMAP. Through this application, the program makes a comparison between the individual evaluations of each item and the importance of the items for the set of subjects. The result is presented in a diagnostic map (PKMAP). Appendix 2 presents the PKMAPs of all the Spanish South Peninsular PAs. However, to facilitate the interpretation of the data, Table 4 schematically includes the strengths and weaknesses that each of the PA has in the different items with respect to the total of the watershed.

### 3.2. Results

With the objective of positioning and analyzing the strengths and weaknesses of the Spanish South Peninsular PAs, an analysis based on the variable “perception of the innovative effort made” by the PAs in different management areas was carried on. In order to do it, first, the map of variables is obtained and analyzed and, secondly, the diagnostic maps.

Due to the analysis is focused only on the South Peninsular PAs, firstly the different activities have been ranked according

Table 4: Summary of the strengths (S) and weaknesses (W) of the Spanish South Peninsular PAs with respect to the total of the watershed, based on the PKMAPs

Item Position	Item Number	Algeciras	Cádiz	Huelva	Málaga	Motril	Sevilla
1	P10-13	S	W	W	W		
2	P10-11			S			
3	P10-10		W	S			
4	P10-12	S		S	W		W
5	P10-14				S	W	S
6	P10-1	S	W		S	W	S
7	P10-8		S	W		S	
8	P10-7	S		W	S	W	
9	P10-6	S		W		S	W
10	P10-3	W	S	S		W	
11	P10-2	W		W	S	S	
12	P10-9	W	S	W	S	S	W
13	P10-5			S			S
14	P10-4	W		S			S
15	P10-16		S	S		S	W
16	P10-15	S	W				S

The strengths of Algeciras might be highlighted. Thus, it could be concluded that Algeciras is better positioned than the other PAs with regard to 'Contingency plans and security systems for protecting infrastructure and environment' and 'Plans and protection systems'. This fact could be due to the strategic geographic location of Algeciras which, not only is a hub port with lots of international traffic movements, but it is also the nearest European port to the North of Africa, with an intense traffic from and to this continent. As a result, Algeciras becomes the front door of Europe for many traffics with an African origin. Therefore, control and security issues become paramount for this PA.

For more information, Table 5 includes, for each of the PAs, the measure, the standard deviation (S.E.) and the score. These values indicate respectively the average value of the distribution (where the xxx are in each graph) and the horizontal lines that represent the average values plus or minus the standard deviation, resulting in the positioning of each port (central strip). The higher the value of this measure the better positioned the port will be. The lower the value of S.E. the more central will be with respect to the average. The score is the sum of the raw scores that the Port Authority gave to all items.

Table 5: Summary of PKMAPs information

	Measure	S.E.	Score
Bahía Algeciras	-1,37	0,36	37
Cádiz	0,23	0,35	50
Huelva	-0,26	0,35	46
Malaga	0,84	0,35	55
Motril	-0,87	0,35	41
Sevilla	1,88	0,37	63

From the observation of the values "measure" and "score", it may be concluded that Sevilla would be the best positioned PA followed by de Málaga, Cádiz, Huelva, Motril and Algeci-

ras.

Finally, the analysis of strengths and weaknesses shows some discrepancies with the traffic analysis.

Despite finding some agreement in the data, we must be cautious with interpretation. Due to ports are asked about "perception", there is a subjective component. In addition, the possible influence of size has to be taken into account: in a small port, a small amount of time or money can be perceived as a great effort; whereas in another port, however, a greater absolute amount may be perceived as a small investment because it is relatively less important compared to its total investments.

On the other hand, the starting situation may be also different from each other. The period requested in the survey was 2004-2008. Thus, if a port had previously made innovation, the effort required to perform later is less, but this would not be reflected in the results.

In the end, according to the study by (Blanco et al., 2011) the greatest innovative effort is made by the companies located in the hinterland of each port, so the total effort, not just the one made by port authority, should be analyzed. This is an aspect that opens new lines of research.

#### 4. Conclusions

In the present study an analysis of the positioning of the Spanish South Peninsular Port Authorities (Almería, Bahía de Algeciras, Bahía de Cádiz, Huelva, Málaga, Motril y Sevilla.) has been carried out.

Firstly, a comparison between the different ports, based on traffic and infrastructures, has been made. Secondly, a strengths and weaknesses analysis has been carried out based on their "perception of the innovative effort made" in various activities of its daily operation.

The individualized analysis has allowed us to see the degree of specialization of the different ports. Almería, Algeciras, Cádiz, Huelva and Málaga are specialized in oil and fat trans-

port, Motril in diesel whereas Sevilla is specialized in chemical products.

Concerning the comparative analysis, in 2012, Huelva and Algeciras were the ports with the highest volume of liquid bulk traffic. Huelva together with Almería were the ports with the highest level of solid bulk traffic. Whereas Algeciras is the most important port regarding general goods traffic, containerized traffic, ro-ro transport and the transport of cars as goods.

With regard to infrastructures, Algeciras has special facilities for containers. This fact is hardly surprising as Algeciras is a hub port involved in international routes and, as a result, the destination of the containerized traffic exceeds the national scope.

The above results give an idea of the specialization of each PA. Knowing the specialization of each PA will allow, in future work, to identify more easily which the companies of the hinterland of each PA are. This is important in order to deepen the analysis of the innovation and competitiveness of the PAs since, according to (Blanco et al., 2011), the companies installed in the PA are responsible for making the investments. Identifying them is a vital first step.

In terms of the PKMAP analysis, first, Sevilla is the first positioned with regard to the "perceived innovative effort". Additionally it is one of the ports with more cranes, followed by Málaga, Cádiz, Huelva, Motril and Algeciras. This ranking is based on a subjective variable as we are talking about "perception". This means that the same investment, in absolute terms, could be differently perceived based on the size of the port. Also is possible that a PA might have done the innovative effort previously. Additionally, in some ports, the PA could have not been responsible for the innovative effort, but a private company from its hinterland. This could be the case of Algeciras which, despite being the first in many of the analysis made, is the last in the Rasch ranking

The results obtained in the work may be of interest to the managers of the PAs, since they allow them to know their situation in front of other competing ports, indicating for example their strengths and weaknesses. All this can be useful for them when making decisions about where to invest their resources to improve their competitiveness.

There is also the need to study in depth private innovation and its impact on the development of the hinterland and the port itself. Analyze the circle of synergies: the port contributes to the economic development of its hinterland, but also the development of the hinterland contributes to the growth of the port.

Overall, it may be concluded that specialization has been a source of competitiveness and survival for the ports of the Spanish South Coast.

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## Appendix A. Survey

According to your point of view, and with reference to the last five years(2004-2008), give a score between 1 (no effort) and 5 (extremely high level of effort) for the degree of effort to innovate that has been made within the Port Authority in the following areas:

Table A.6:

1	Strategic planning (business plan development, annual reports, planning for the use of port areas, objective monitoring, etc.)
2	Human resources (selection, training, internal promotion, labor relations, etc.)
3	Port services (the control of operations, the regulation of services, etc.)
4	The management of concessions and authorizations
5	Sales and marketing (Searching for new traffic, relationships with clients, carrying out studies, etc.)
6	Finance and economics (economic management, coordination and budgeting, internal financial control, etc.)
7	Legal services and administrative management (e-administration)
8	External relations (corporate image, web, community relations with the port and city communities)
9	Quality (quality systems and certifications, etc.)
10	Environmental Issues (environmental impact, sustainability, waste management, certifications, etc.)
11	Information systems, communication and control systems (IT, telematics, cameras and sensors, etc.)
12	Plans and Protection systems (ships and port facilities)
13	Contingency plans and security systems for protecting infrastructure and the environment (port operations and services, monitoring and forecasting of environmental effects)
14	Projects and construction (the design and development of new infrastructure and port facilities)
15	Maintenance (the management of a preventive maintenance plan and a plan for the maintenance of infrastructure)
16	Promotion and Sponsorship of scientific and technological R & D within the port (Agreements with universities or research centers, research grants and doctoral programs and the development of patents, etc.)

## Appendix B. PKMAPS of the Spanish South APs

Figure B.10: Algeciras PKMAP

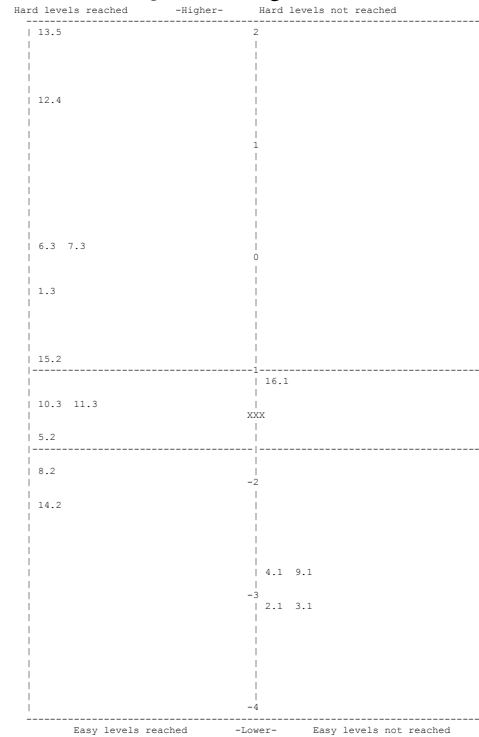


Figure B.11: Cádiz PKMAP

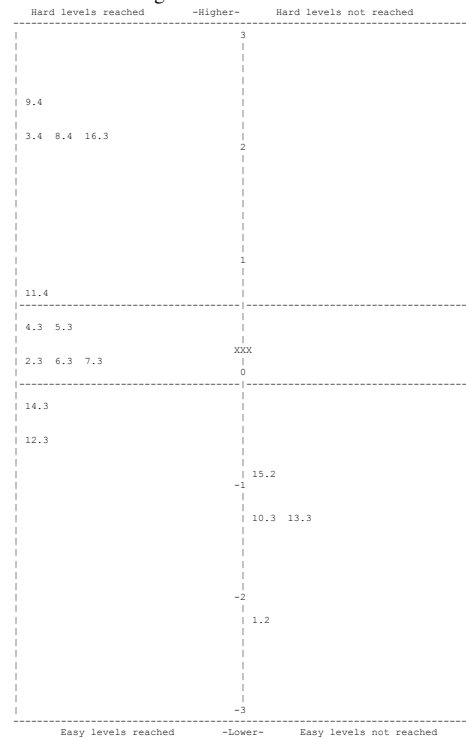
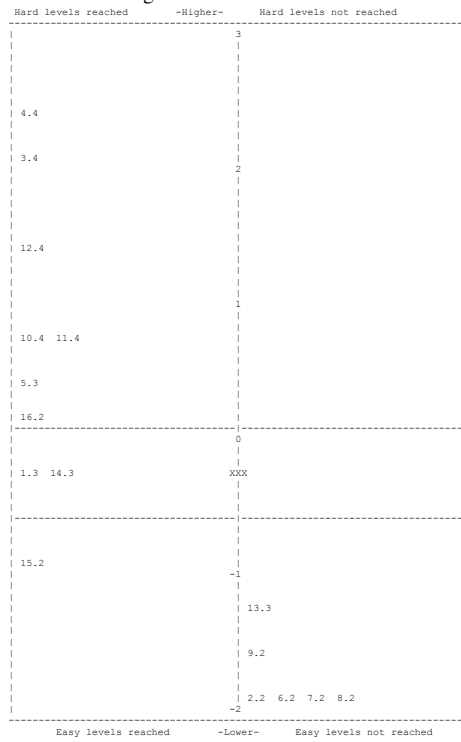


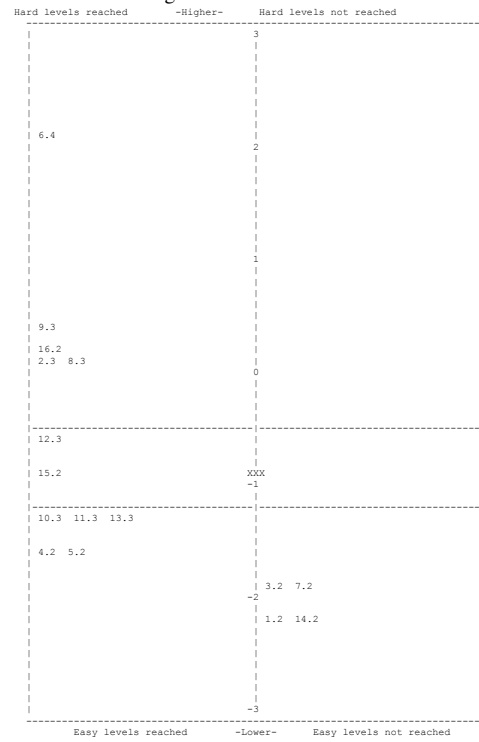


Figure B.12: Huelva PKMAP



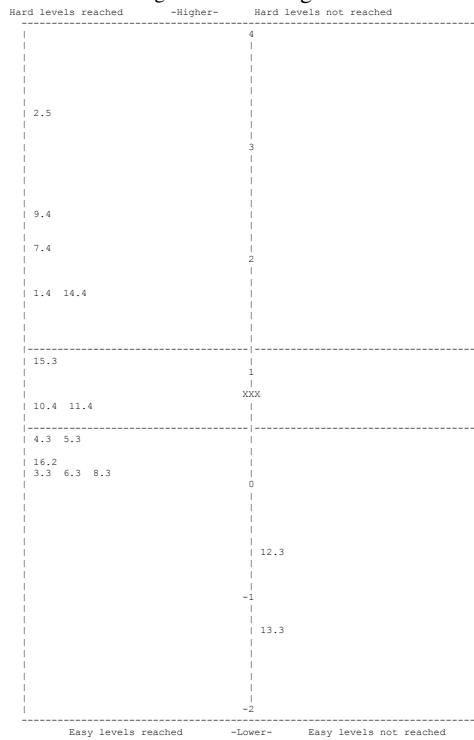
Source: Own elaboration

Figure B.14: Motril PKMAP



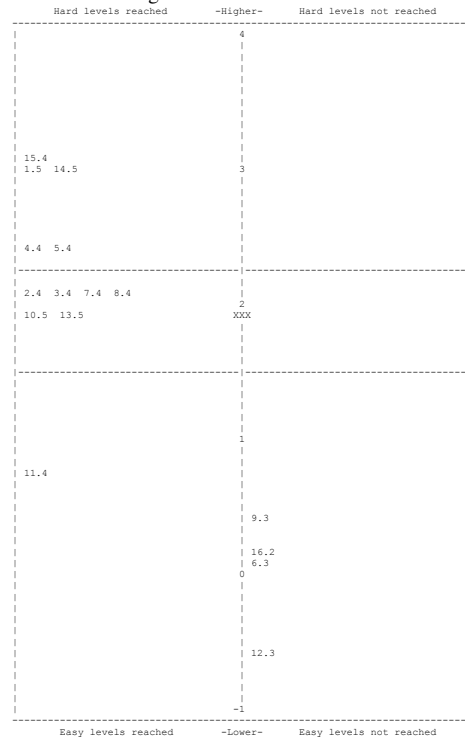
Source: Own elaboration

Figure B.13: Málaga PKMAP



Source: Own elaboration

Figure B.15: Sevilla PKMAP



Source: Own elaboration